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TM 11-2624B

WAR DEPARTMENT TECHNICAL MANUAL

VOLTOHMMETERS

TS-294/U

AND

TS-294B/U

WAR DEPARTMENT • APRIL 1945

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TM 11-2624B

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WAR DEPARTMENT • *APRIL 1945*

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TM 11-2624B, Voltohmmeters TS-294/U and TS-294B/U, is published for the information and guidance of all concerned.

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(For explanation of symbols see FM 21-6.)

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DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN— When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT— 1. Smash — Meter, tubes, switches, case, chassis.

2. Cut — Wiring.

3. Burn — Manuals, schematic diagrams.

4. Bury or scatter — All of the above materials after destroying their usefulness.

DESTROY EVERYTHING

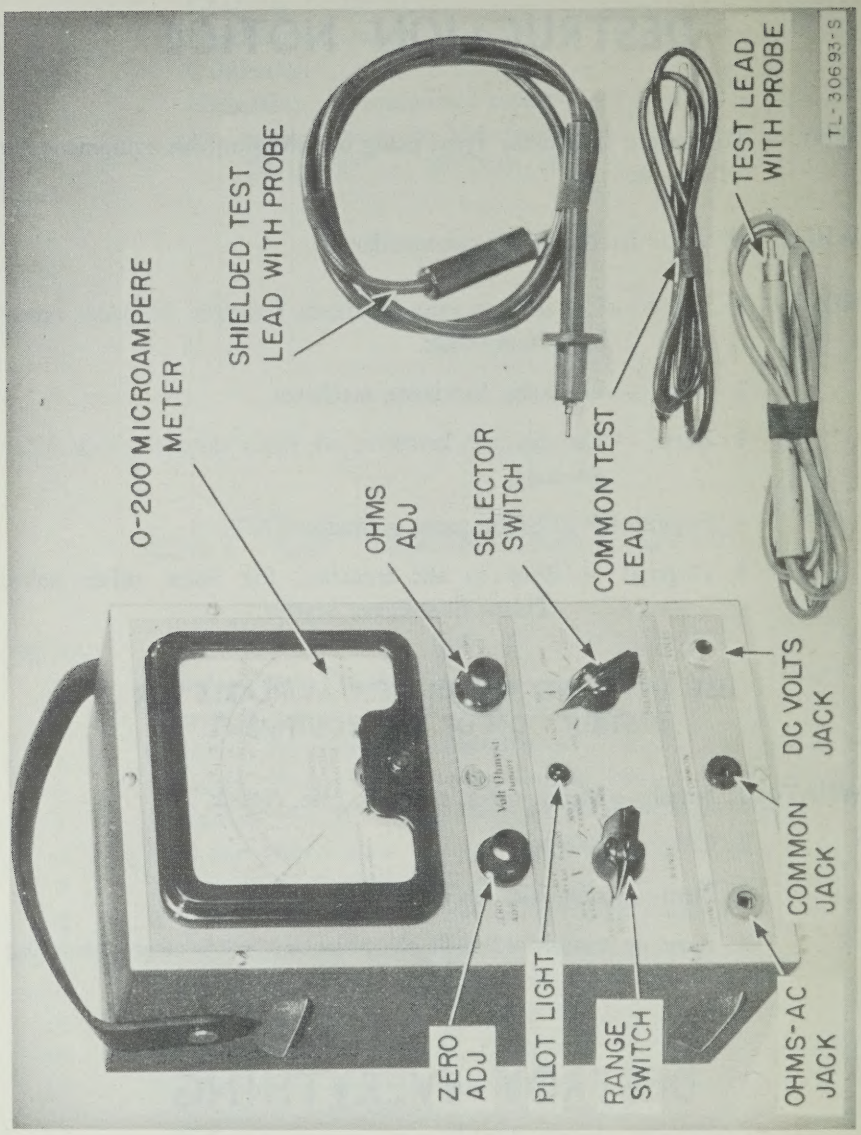

Figure 1. Voltohmmeter TS-294B/U.

PART ONE

INTRODUCTION

1. DESCRIPTION (fig. 1).

Voltohmmeters TS-294/U and TS-294B/U (RCA Junior Voltohmyst, types 165 and 165A respectively) will measure alternating-current (a-c) and direct-current (d-c) voltage and resistance over a wide range. Differences between the two voltohmmeters are explained in paragraph **6**. Each instrument consists basically of a 200-microampere d-c meter, a d c amplifier, a copper-oxide rectifier, a 3-volt battery (internal), and a power supply. All readings are taken on the scales of the d-c microammeter. A 115-volt, 60-cycle supply is required for operation of the instrument as a d-c voltmeter or ohmmeter. No power supply is required for making a-c voltage measurements.

2. USE.

a. D-C Voltage Measurements.

(1) When the SELECTOR switch (fig. 1) is in either the —VOLTS or +VOLTS position, the instrument functions as a vacuum-tube voltmeter. The voltages are read on the d-c microammeter (fig. 2). Voltages from 0.05 volt to 1,000 volts can be measured in five ranges. The input resistance is constant at 11 megohms on all ranges.

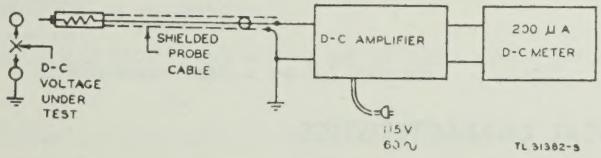

Figure 2. Operation for d-c voltage measurement.

(2) The shielded cable is plugged into the DC VOLTS jack on the front panel (fig. 1) for d-c voltage measurements. This cable terminates in a test prod which is isolated by means of a 1-megohm resistor built into the probe. The purpose of this resistor is to enable the measurement of d-c voltages while a signal is present at the test point without loading the circuit under test.

(3) Since it is essential to maintain the case of the instrument at ground potential, the circuit SELECTOR switch has a +VOLTS and a —VOLTS position. This makes it possible to measure positive and negative voltages without changing the ground lead.

b. Resistance Measurements. When the circuit SELECTOR switch is in the OHMS position, the instrument functions as a vacuum-tube voltmeter as shown in figure 3. A small 3-volt battery (not shown in fig. 3) provides the test voltage. The input terminals are the COMMON and OHMS-AC terminals. Six ohmmeter ranges are provided, and resistances from 0.1 ohm to 1,000 megohms can be measured. The instrument can also be used in a special set-up (par. **11**) to measure resistances above 1,000 megohms.

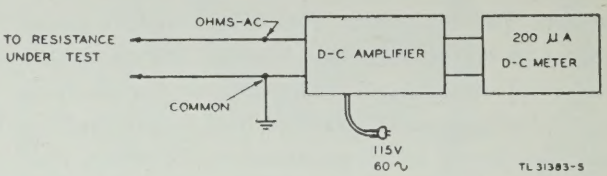

Figure 3. Operation for resistance measurement.

c. A-C Voltage Measurements. With the circuit SELECTOR switch in the AC VOLTS position, the instrument is completely isolated from the line and power supply (fig. 4). A copper-oxide rectifier, in series with the meter, rectifies the a-c voltage. The resistance of the voltmeter on a-c ranges is 1,000 ohms per volt. Use of the meter on a-c ranges is limited to sine waves at power-supply and audio frequencies. Typical applications are the measurements of line voltage, of secondary voltages of power supply transformers, and of audio-frequency voltages developed across output transformers or voice coils.

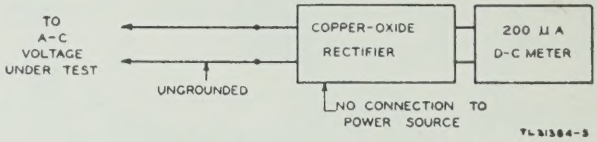

Figure 4. Operation for a-c voltage measurement.

3. TECHNICAL CHARACTERISTICS.

The following characteristics apply to both Voltohmmeter TS-294/U and TS-294B/U.

a. Range.

(1) D-C voltmeter: zero to 3, 10, 30, 100, 300, and 1,000 volts.

(2) A-C voltmeter: zero to 10, 30, 100, 300, and 1,000 volts.

(3) Ohmmeter: six ranges measuring from 0.1 ohm to 1,000 megohms.

b. Accuracy. The accuracy is 2 percent of full scale.

c. Sensitivity.

(1) D-C voltmeter: 3,660,000 ohms per volt on 3-volt scale.

(2) A-C voltmeter: 1,000 ohms per volt.

d. D-C Input Resistance. This resistance is 11 megohms constant for all ranges.

e. Indicating Meter. The meter has a sensitivity of 200 microamperes direct current for full-scale deflection.

f. Power Supply. The input power source is 115 volts, 60 cycles. Two 1½-volt batteries are used for resistance measurements.

g. Tubes.

(1) One type 6X5GT tube is used as a power-supply rectifier.

(2) Two type 6K6GT tubes are used in the push-pull electronic amplifier circuit.

h. Power Consumption. The power consumption is 12 watts.

i. Shipping Weight. The weight is approximately 14 pounds.

j. Dimensions. The voltohmmeter is 9½ inches high by 6$^{5}/_{16}$ inches wide by 6½ inches deep.

4. UNPACKING.

Unpack the instrument carefully, since the meter can be damaged easily. After unpacking, inspect the instrument case and meter for any external evidence of damage.

5. INSTALLATION.

a. The instrument is shipped with a set of tubes and a set of batteries installed.

b. Three cables are supplied with the unit as follows:

(1) One black lead with clip, which plugs into the COMMON jack.

(2) One red lead with probe, which plugs into the AC-OHMS jack.

(3) One blue shielded lead with probe, which plugs into the DC VOLTS jack.

c. The power-supply requirement is 115 volts, 60 cycles.

d. Do not plug the instrument into the line before reading the instructions on initial adjustments given in paragraph **7**.

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6. DIFFERENCES IN MODELS.

Voltohmmeter TS-294/U is the RCA Junior Voltohmyst No. 165. Voltohmmeter TS-294B/U is the RCA Junior Voltohmyst No. 165A.

a. External Differences. The only external difference between the two models is in the power switch. The TS-294/U has a separate power ON-OFF toggle switch on the front panel, and the SELECTOR switch on this model has only four positions. On the TS-294B/U, the SELECTOR switch has a fifth position labeled OFF which turns off the power to the instrument.

b. Internal Differences.

(1) The chief internal difference between the two models is in the manner in which the switching for negative and positive d-c voltages is accomplished (figs. 10 and 11). In the TS-294/U the grid of V2 is permanently grounded, and the voltage to be measured is always applied to the grid of V1. The SELECTOR switch reverses the connections to the meter. In the TS-294B/U the input voltage is switched to the grid of V1 or V2 by the selector switch, and the meter remains connected across the circuit in the same direction for both negative and positive voltage measurements.

(2) Voltohmmeter TS-294/U has only one d-c voltage calibrating resistor, R22 (figs. 10 and 16). Voltohmmeter TS-294B/U has two calibrating resistors, R22 for the —VOLTS CAL. and R36 for the +VOLTS CAL. (fig. 11). In some instruments of the TS-294B/U model, R33 is mounted on top of the chassis, and in others R33 is mounted on a bracket beneath the chassis (figs. 13, 14, and 15).

(3) In addition to the differences described above, there are some differences in values of circuit elements (figs. 10 and 11).

PART TWO

OPERATING INSTRUCTIONS

CAUTION: In order to measure voltages, place the meter on a wooden table. Use the utmost care to avoid accidental contact with or even close proximity to high-voltage points. If at all possible when making high-voltage measurements, attach the test leads to the circuit to be measured with the power turned off. Then turn on the power, read the meter, and turn the power off again. When measuring the voltage between two points neither of which is at ground potential, take readings between ground and each of the two points. The difference between the two readings will then be the voltage existing between the points in question.

7. INITIAL ADJUSTMENTS.

The procedure for setting up Voltohmmeters TS-294/U and TS-294B/U is described in this paragraph. The procedure is the same for both models except as otherwise noted. The instrument should **not** be plugged into the 115-volt, 60-cycle line until the preliminary steps noted below have been taken.

a. Meter Zero.

(1) Plug the red lead into the pin jack marked OHMS-AC, plug the black lead into the pin jack marked COMMON, and plug the blue lead into the pin jack marked DC VOLTS (fig. 1).

(2) Check the zero setting of the meter. If the pointer does not line up with the zero marks on the scales, insert a small screwdriver into the slot of the meter adjusting screw and turn the screw to the right or left until the pointer lines up with the zero marks. View the meter full-on in order to avoid visual error in lining up the marks (parallax). Do not turn the adjusting screw more than necessary or the meter may be damaged.

(3) This adjustment of the meter zero, which is made with no power on, is seldom required after the initial adjustment.

b. ZERO ADJ. Control.

(1) Plug the power cord into the 115-volt, 60-cycle a-c supply. Turn the power on and turn the SELECTOR switch to the +VOLTS position. The pilot lamp will light. Allow several minutes for the instrument to warm up.

(2) Adjust the ZERO ADJ. control, on the left center of the front panel, until the meter pointer reads zero. The ZERO ADJ. control compensates for differences between the two tubes in the balanced d-c amplifier.

c. OHMS ADJ. Control. Turn the SELECTOR switch to the OHMS position (fig. 1). The meter pointer will deflect to approximately full scale. Adjust the OHMS ADJ. control, on the right center of the front panel, until the meter pointer rests exactly over the last line on the OHMS scale. View the meter full-on to avoid parallax.

8. D-C VOLTAGE MEASUREMENTS.

Similar procedures are used for measuring positive and negative voltages. To measure positive voltages, the SELECTOR switch is set in the +VOLTS position; to measure negative voltages, the SELECTOR switch is set in the —VOLTS position.

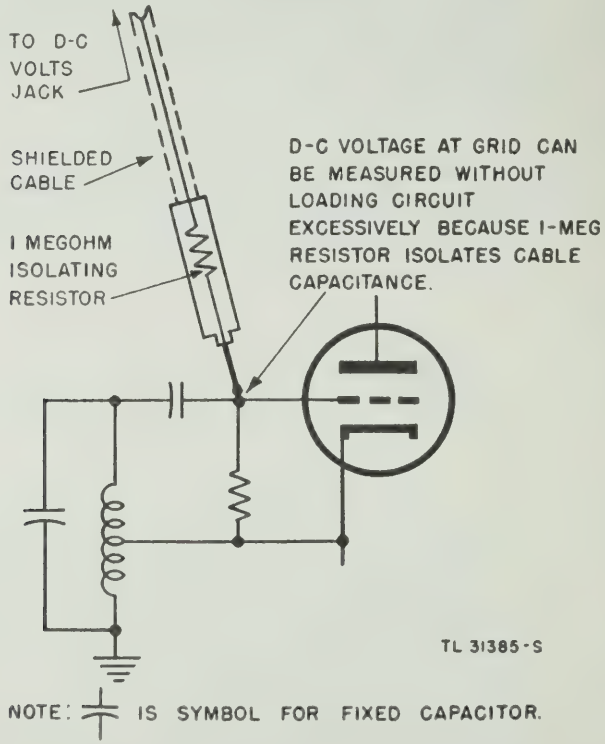
TO D-C VOLTS JACK
SHIELDED CABLE
1 MEGOHM ISOLATING RESISTOR
D-C VOLTAGE AT GRID CAN BE MEASURED WITHOUT LOADING CIRCUIT EXCESSIVELY BECAUSE 1-MEG RESISTOR ISOLATES CABLE CAPACITANCE.
TL 31385-S
NOTE: IS SYMBOL FOR FIXED CAPACITOR.

Figure 5. Measurement of d-c voltage with a-c component present.

a. Procedure.

(1) Set the meter ZERO ADJ. control as described in paragraph **7**.

(2) Connect the ground lead (black lead with alligator clip on one end) to the ground terminal of the apparatus on which voltage measurements are to be made, or to the low-potential side of the voltage to be measured.

(3) Set the RANGE switch to the proper range for the voltage to be measured. Set the SELECTOR switch to —VOLTS or +VOLTS according to the polarity of the voltage.

(4) Plug the blue voltmeter lead into the pin jack marked DC VOLTS.

(5) Place the probe of the blue lead in contact with the point at which the d-c voltage is to be measured, being careful to keep the fingers away from the probe tip to avoid stray pick-up.

(6) Greatest accuracy is always obtained when the meter deflection is as close as possible to full scale. Therefore, it is always advisable to use whatever setting of the RANGE switch will produce this deflection.

(7) All d-c voltages are read on the middle scale marked V.D.C. (fig. 6). Read the voltage to be measured on the proper d-c scale as follows:

Unknown voltage	*Range*	*Scale*	*To read*
0 to 3 volts	3V.DC	0-3.0	Read directly
3 to 10 volts	10V.	0-10	Read directly
10 to 30 volts	30V.	0-3.0	Multiply by 10
30 to 100 volts	100V.	0-10	Multiply by 10
100 to 300 volts	300V.	0-3.0	Multiply by 100
300 to 1,000 volts	1000V.	0-10	Multiply by 100

(8) For greatest accuracy, select the range in accordance with the above table so that a reading is obtained over the upper part of the scale. Use the highest range first in measuring an unknown voltage; switch to a lower range if necessary. Never attempt to use a reading which is slightly beyond the last calibration mark on the meter scale, because such readings are likely to be very inaccurate.

b. Application to A-C and D-C Potential Points. The shielded cable supplied with Voltohmmeters TS-294/U and TS-294B/U is provided with a 1-megohm resistor built into the probe. By use of this cable it is possible to measure d-c voltages at any point in a circuit even though an a-c or r-f voltage is present at the test point.

(1) The grid bias voltage, developed across the grid leak of an oscillator tube because of the oscillation, can be measured as shown in figure 5. The r-f signal present at the test point is not affected appreciably, and the d-c voltage

at the grid, produced as the result of the amplitude of the oscillation, can be measured readily.

(2) The automatic volume control (avc) voltage developed by an incoming signal can be measured readily by Voltohmmeters TS-294/U and TS-294B/U. This voltage first appears across the diode load resistor. It may be measured also along the avc bus and at the grids of the r-f tubes being controlled. This d-c voltage, measured at the diode load resistor, is a convenient output indication during receiver alignment.

(3) The discriminator voltage developed in radio and radar receivers utilizing automatic frequency control can be measured at the discriminator load resistors and also at the grid of the reactance tube oscillator (control tube).

(4) The d-c voltage developed by the discriminator in a frequency modulation receiver can be measured at the discriminator load resistors.

c. Application to High Impedance Points. Voltohmmeters TS-294/U and TS-294B/U have a high input impedance and therefore draw little current. For this reason they can be used to measure voltages obtained from sources which cannot supply the current drawn by ordinary voltmeters.

(1) Gas in a tube produces a positive charge on the control grid instead of the negative charge which is normally present. Voltohmmeters TS-294/U and TS-294B/U may be used to measure the voltage on the control grid of the tube in order to determine whether or not this condition is present.

(2) Leakage in the insulation of coupling capacitors used between the plate of one tube and the grid of another will manifest itself as a positive voltage on the grid of the second tube. This voltage can be measured at the grid of the second tube.

9. A-C VOLTAGE MEASUREMENTS.

In measuring a-c voltages, it is immaterial whether or not the instrument is plugged into the power line. The procedure is as follows:

a. Set the meter ZERO ADJ. control as described in paragraph **7**.

b. Set the SELECTOR switch in the AC VOLTS position.

c. Turn the RANGE switch to a higher scale than the voltage to be measured before the test leads are connected to this voltage. If necessary, the RANGE switch can then be rotated to a lower scale. This proecdure will protect the meter from overloads which might damage the instrument.

d. Plug the red lead into the jack marked OHMS-AC and the black lead into the jack marked COMMON.

e. Connect the lead terminals to the circuit points under test, being careful to keep the fingers away from the probe tips to avoid stray pick-up.

f. For greatest accuracy in a-c measurements, use a setting of the RANGE switch which will produce a deflection as close to full scale as possible.

CAUTION: If it is necessary to change the setting of the RANGE switch when a measurement is being made, remove the leads from the test points before setting the RANGE switch to the new position. Arcing inside the meter may result if this precaution is not taken.

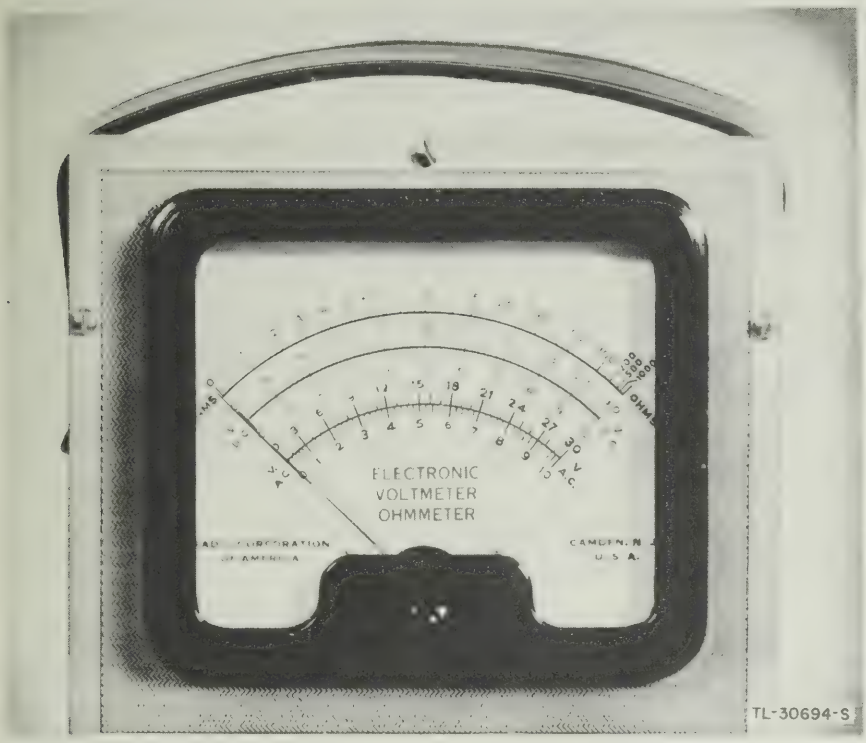

Figure 6. Volt and ohm scales.

g. All a-c voltages are read on the bottom scale marked V.A.C. (fig. 6). Read the voltage to be measured on the proper a-c scale as follows:

Unknown voltage	*Range*	*Scale*	*To read*
0 to 10 volts	10V.	0-10	Read directly
10 to 30 volts	30V.	0-30	Read directly
30 to 100 volts	100V.	0-10	Multiply by 10
100 to 300 volts	300V.	0-30	Multiply by 10
300 to 1,000 volts	1000V.	0-10	Multiply by 100

h. For measuring a-c voltages when d-c voltages are also present, a 1-microfarad (or larger) capacitor must be used in series with either test lead. This will eliminate the d-c component and allow the a-c component to be measured. If high d-c voltage is applied to the a-c circuit, the rectifiers will be damaged. This arrangement makes possible the use of Voltohmmeters TS-294/U and TS-294B/U to measure ripple voltages in power supply filter circuits.

10. RESISTANCE MEASUREMENTS.

Before attempting any resistance measurements with Voltohmmeter TS-294/U or TS-294B/U, see that the resistance being measured is not connected across any source of voltage and also that no voltage exists between either terminal of the resistance and ground.

a. Set the meter ZERO ADJ. and OHMS ADJ. controls as described in paragraph **7**.

b. Plug the red lead into the jack marked OHMS-AC and the black lead into the jack marked COMMON.

c. Rotate the SELECTOR switch to the OHMS position.

d. Connect the two test leads across the resistance to be measured.

e. Rotate the RANGE switch until a reading is obtained which is as near midscale deflection as possible. The resistance in ohms is obtained by multiplying the reading shown on the OHMS scale by the factor indicated on the RANGE scale.

f. The Rx1 position of the RANGE switch should be used only for resistance measurements below 20 ohms.

g. To cancel the lead-resistance error when making measurements below 2 ohms, short the test leads together and reset the ZERO ADJ. control so that the pointer reads exactly zero. This new setting will be slightly different from the original setting because of the resistance of the teast leads. After the readjustment, make the regular resistance check. When the measurement has been completed, the ZERO ADJ. control should be adjusted as described in paragraph **7**.

h. When measuring high resistances, keep the fingers away from the red lead and its probe. This will eliminate possible error due to leakage and stray pick-up. This is especially important on the Rx10,000 and Rx1MEG. ranges.

i. In order to facilitate the checking of resistors, a color code chart for resistances is included at the end of the manual (fig. 18).

CAUTION: Since the instrument applies a voltage up to 3 volts across the resistance being measured, it is possible to burn out low filament voltage tubes in attempting a continuity or resistance check across their filaments. The approximate voltages applied by the instrument across resistances being measured are as follows for all positions of the RANGE switch: one-fourth-scale meter reading, 0.75 volt; half-scale meter reading, 1.5 volts; three-fourths-scale meter reading, 2.25 volts; full-scale meter reading, 3.0 volts.

11. HIGH-RESISTANCE MEASUREMENTS.

The voltmeter section of the voltohmmeter can be used to measure resistances higher than those covered by the Rx1MEG. range. This application is especially useful in measuring leakage resistance of paper and mica capacitors which, for the smaller values of capacitance, is usually above 1,000 megohms.

a. An external voltage supply is required as shown in figure 7. This voltage may range in value from 20 to 500 volts. The higher the voltage, the higher the value of resistance it is possible to measure.

b. Make the connections indicated in figure 7. Note the reading, using the most convenient range. If the voltage at point B is too small to be read accurately, increase the value of the external power supply until the voltage at B can be measured.

c. The unknown resistance is found from the following formula:

$$\text{Unknown resistance (in megohms)} = \frac{\text{Reading at A minus reading at B}}{\text{Reading at B}} \times 11 \text{ megohms.}$$

Example: External voltage supply is 500 volts, measured on the 1,000-volt range. Voltage at B measured on the 3-volt range is 0.5 volt.

$$\text{Unknown resistance} = \frac{500 - 0.5}{0.5} \times 11 \text{ megohms} = 11{,}000 \text{ megohms.}$$

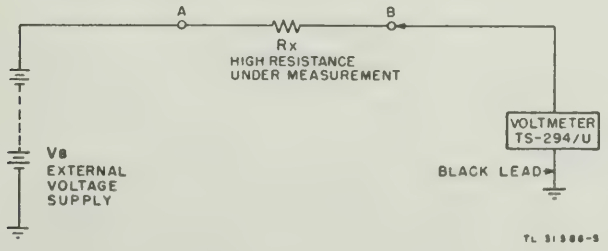

Figure 7. Measurement of high resistance.

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PART THREE

PREVENTIVE MAINTENANCE

12. INTRODUCTION.

Preventive maintenance is a systematic series of operations performed at regular intervals on equipment, when turned off, to eliminate major break-downs and unwanted interruptions in service and to keep the equipment operating at top efficiency. To understand what is meant by preventive maintenance, it is necessary to distinguish preventive maintenance from trouble shooting and repair. The primary function of preventive maintenance is to **prevent** break-downs and, therefore, the need for repair. On the other hand, the primary function of trouble shooting and repair is to locate and correct **existing** defects. The importance of preventive maintenance cannot be overemphasized. The entire system of radar operations depends upon the readiness and operating efficiency of each item of equipment when it is needed. The test equipment by which this condition of readiness is realized must therefore be kept in excellent operating condition at all times.

13. DESCRIPTION OF TECHNIQUES.

a. General. Voltohmmeter TS-294/U requires routine preventive maintenance. Because hit-or-miss maintenance techniques cannot be applied, definite and specific instructions are needed. This part of the manual contains these specific instructions and serves as a guide for personnel assigned to perform the six basic maintenance operations, namely: Feel, Inspect, Tighten, Clean, Adjust, and Lubricate. The lettering system for the six operations is as follows:

F — Feel.*
I — Inspect.
T — Tighten.
C — Clean.
A — Adjust.
L — Lubricate.*

The first two operations establish the need for the other four. The selection of operations is based on a general knowledge of field needs. For example,

* The Feel and Lubricate operations do not apply to this equipment.

the dust encountered on dirt roads during cross-country travel filters into the equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the necessary performance of tightening and cleaning operations, equipment becomes undependable and may break down when it is most needed.

b. Inspect. Inspection is the most important operation in the preventive maintenance program. A careless observer will overlook the evidences of minor trouble. Although these defects may not interfere with the performance of the equipment, valuable time and effort can be saved if they are corrected before they lead to major break-downs. Make every effort to become thoroughly familiar with the indications of normal functioning, in order to be able to recognize the signs of a defective set. Inspection consists of observing carefully all parts of the equipment, noticing color, placement, state of cleanliness, etc. Inspect for the following conditions:

(1) Overheating, as indicated by discoloration, blistering, or bulging of the parts or surface of the container, and oxidation of metal contact surfaces.

(2) Placement, by observing that all leads and cabling are in their original positions.

(3) Cleanliness, by carefully examining all recesses in the unit for accumulation of dust, especially between connecting terminals. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity locations, look for fungus growth and mildew.

(4) Tightness, by testing any connection or mounting which appears to be loose.

c. Tighten, Clean, and Adjust. These operations are self-explanatory. Specific procedures to be followed in performing them are given wherever necessary throughout part three.

CAUTION: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Whenever a loose connection is tightend, it should be moistureproofed and fungiproofed again by applying the varnish with a small brush. See paragraph 17 for details of moistureproofing and fungiproofing.

14. COMMON MATERIALS NEEDED.

The following materials will be needed in performing preventive maintenance:

Common hand tools (Tool Equipment TE-41 or equivalent).
Clean cloth.
Sandpaper #0000.
Crocus cloth.
Solvent, Dry-cleaning, Federal Specification P-S-661a.

NOTE: Gasoline will not be used as a cleaning fluid for any purpose. Solvent, Dry-cleaning, Federal Specification P-S-661a, is available as a cleaning fluid through established supply channels. Oil, Fuel, Diesel, U. S. Army Specification 2-102B, may be used for cleaning purposes when dry-cleaning solvent is not available.

15. PREVENTIVE MAINTENANCE OF VOLTOHMMETERS TS-294/U AND TS-294B/U.

The preventive maintenance operations described below should be performed on the voltohmmeter at least once a month.

a. Inspect (I). Examine all parts of the equipment, noting the general condition of the instrument and the state of cleanliness. Inspect all tubes, tube sockets, resistors, capacitors, batteries, transformers, and wiring. Look for accumulations of dirt and for corrosion. Press the tubes down in their sockets and inspect them for firmness. Examine all wiring for placement and for defective insulation. Inspect all terminals and mounting screws for tightness. Examine the insulation of cables.

b. Tighten (T). All loose terminals, mountings, and connections (par. **13c**).

c. Clean (C). Keep the instrument thoroughly clean. All corrosion must be removed from metal parts and connections, using crocus cloth or fine sandpaper if necessary. Dust, dirt, and other foreign matter can be removed by using a small brush or a clean cloth moistened with a cleaning solvent. When cleaning solvent has been used, always wipe the surfaces dry with a clean cloth. Clean the tubes only if inspection shows cleaning to be necessary.

d. Adjust (A). The only adjust procedure required is the occasional adjustment of the zero of the meter. See paragraph **7a** for the procedure.

16. LUBRICATION.

Lubrication is not required on Voltohmmeters TS-294/U and TS-294B/U.

17. MOISTUREPROOFING AND FUNGIPROOFING.

a. General. Signal Corps equipment requires special attention in tropical areas where temperature and relative humidity are extremely high. The following items represent problems which may be encountered in operation:

(1) Resistors, capacitors, chokes, transformer windings, etc., fail.

(2) Electrolytic action takes place in resistors, chokes, transformer windings, etc., causing eventual break-down.

(3) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs.

(4) Hook-up wire insulation and cable insulation break down. Fungus growth accelerates deterioration.

(5) Moisture provides leakage paths between battery terminals.

b. Treatment. A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, salt spray, corrosion, and moisture. The treatment involves the use of a moisture- and fungi-resistant lacquer or varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish and lacquer spray method of moistureproofing and fungiproofing and the supplies and equipment required in this treatment.

CAUTION: Varnish or lacquer spray may have poisonous effects if inhaled. To avoid inhaling spray, use respirator if available; otherwise, fasten cheesecloth or other cloth material over the nose and mouth. Varnish spray is inflammable; do not spray near an open flame.

c. Step-by-step Instructions for Treating Voltohmmeters TS-294/U and TS-294B/U.

(1) Preparation. Make all repairs and adjustments necessary for proper operation of the equipment.

(2) Disassembly.

(a) Remove the eight screws from the outer edges of the front panel.

(b) Remove the two screws in the rear of the case.

(c) Remove the chassis from the case.

(d) Disconnect the leads from the battery.

(e) Remove the batteries from the case.

(f) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment.

(3) Masking. No masking is necessary.

(4) Drying. Dry the equipment in an oven or under heat lamps for 6 hours at 140° F.

(5) Varnishing.

(a) Apply three coats of moistureproofing and fungiproofing varnish (Lacquer, Fungus-resistant, Spec No. 71-2202, stock No. 6G1005.3, or equal). The varnish must be applied immediately after the equipment is re-

moved from the oven. Otherwise, moisture condenses on the equipment. Varnish applied over the moisture peels off readily after the varnish has dried.

(b) Brush-coat the entire assembly on the rear of the front panel.

(c) Brush-coat all textile-covered wiring.

CAUTION: Do not allow varnish to coat tube prong contacts, rotating shafts, or switch contacts.

(d) Brush-coat all phenolic parts.

(e) Brush-coat the meter housing on the front of the front panel. Care should be taken to assure a complete seal around the glass face and around the outer edges between the meter housing and the panel.

(f) Spray the entire case, inside and outside, with one coat of varnish.

(6) Reassembly.

(a) Clean and burnish all contacts.

(b) Rassemble the equipment and test its operation.

(7) Marking. Mark the letters MFP and the date of treatment in a convenient place on the front panel where it will not be obliterated or rubbed off.

Example: MFP — 1 Mar 45.

NOTE: When replacing defective parts after the set has been moisture-proofed and fungiproofed, use a brush to touch up exposed surfaces of new parts with fungus-resistant lacquer.

PART FOUR

AUXILIARY EQUIPMENT

(Not Used)

PART FIVE

REPAIR INSTRUCTIONS

NOTE 1: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report); by Army Air Forces on Army Air Forces Form No. 54 (Unsatisfactory Report). If either form is not available, prepare the data according to the sample form reproduced in figure 17.

NOTE 2: The theory discussion given below is based on Voltohmmeter TS-294B/U. However, it applies also to the TS-294/U except as otherwise noted.

18. GENERAL THEORY.

a. Voltohmmeters TS-294/U and TS-294B/U consist of the following basic parts:

(1) A two-tube balanced d-c amplifier.

(2) A 200-microampere d-c meter which indicates changes in plate voltage of the d-c amplifiers when a voltage is applied to the grid of one of the two tubes.

(3) Copper-oxide rectifiers for converting a-c voltages to d-c voltages so that they can read on the meter.

(4) An a-c operated power supply for providing filament and plate voltages.

b. When the instrument is used to measure d-c voltages, the unknown d-c voltage is applied directly to the grid of one of the tubes in the balanced d-c amplifier circuit. A d-c microammeter is connected to read the resulting change in plate voltage between the two d-c amplifier tubes. The scale of the meter is calibrated to read directly the voltage applied to the grid. Positive or negative voltages are measured by the d-c amplifier circuit without changing leads or the connections to the 200-microampere meter. This is done by the use of the SELECTOR switch which applies the unknown voltage to the grid of one or the other of the tubes in Voltohmmeter TS-294B/U. In the TS-294/U model the SELECTOR switch reverses the connections of the meter.

c. When the meter is used to measure resistance, the unknown resistance is connected as part of a voltage divider across a battery. The resulting voltage drop across the resistor is applied to the input of the d-c amplifier circuit, and the resistance is read on the ohm scale of the meter.

d. When the meter is used to measure a-c voltages, the a-c voltage is applied to the copper-oxide rectifier and converted to a d-c voltage which is read directly by the meter. The d-c amplifier circuit is not used when measuring a-c voltages.

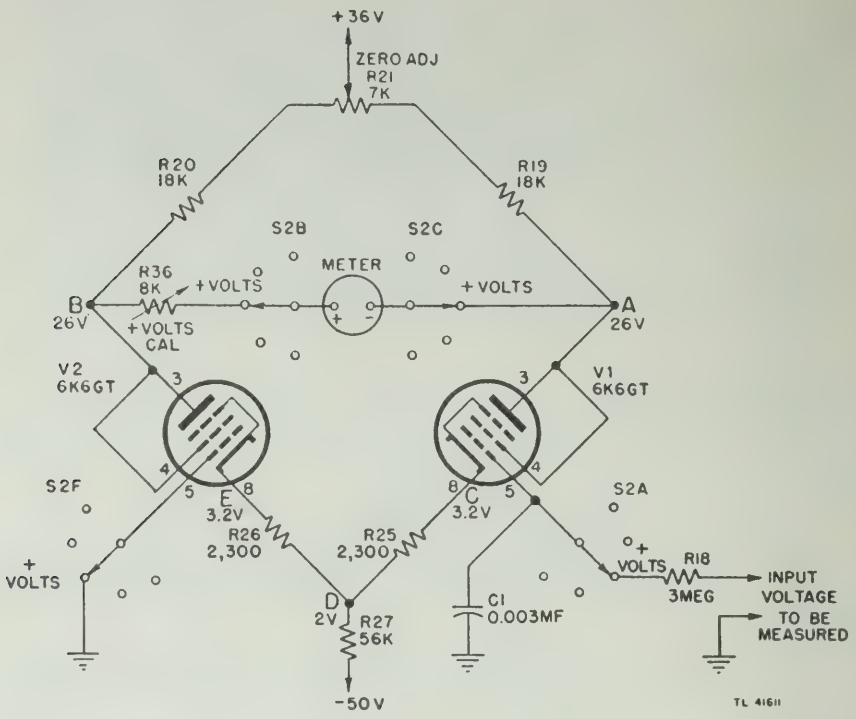


Figure 8. D-C amplifier circuit, simplified schematic diagram.

19. BALANCED D-C AMPLIFIER CIRCUIT.

a. Basic Circuit.

(1) Figure 8 is a simplified schematic diagram of the d-c amplifier in Voltohmmeter TS-294B/U with the SELECTOR switch in the +VOLTS position. In Voltohmmeter TS-294/U the connections are slightly different (fig. 10) but the operation is the same. The d-c amplifiers, V1 and V2 (6K6GT tubes), are connected in a cathode-coupled push-pull circuit. The microammeter and its calibrating resistor, R36, are connected in series between the plates of the two amplifiers. Voltage from the power supply is

applied between R27 and the movable tap of R21. With the grids of both amplifiers grounded, current in both tubes is adjusted to the same value by varying their plate voltages with variable resistor R21, the ZERO ADJ. potentiometer. In the balanced condition the current in each arm of the circuit is approximately 0.45 milliampere. There is no voltage difference between the plates of the amplifiers, and no current flows through the microammeter.

(2) If a positive voltage is applied to the grid of V1, current in V1 increases causing the voltage at point A to decrease. At the same time the voltage at points C, D, and E tends to increase because of the increased current in the cathode circuit. The increase of voltage at the cathode of V2 increases the bias on V2. Current in V2 then decreases, causing the voltage at B to increase. There is now a difference in potential between points A and B, and a current which is directly proportional to the voltage at the grid of V1 flows through the microammeter. The current, and therefore the meter deflection, corresponding to a given voltage at the grid of V1 is determined by the setting of R36. Resistor R36 is set so that the meter deflection indicates the voltage at the grid of V1.

(3) A large degree of self regulation is obtained because of the high value of coupling resistor R27. The amount of inverse feedback in the two cathode circuits is controlled by resistors R25 and R26. Capacitor C1 bypasses any a-c components of the applied voltage.

b. Measurement of Negative Voltage.

(1) When a negative voltage is to be measured with Voltohmmeter TS-294B/U, the voltage is applied to the grid of V2 and the grid of V1 is grounded. The operation of the circuit is the same as above, and the meter reads in the same direction. Resistor R22 is used to calibrate the meter readings (figs. 10 and 11). Capacitor C3 bypasses a-c components.

(2) When a negative voltage is measured with Voltohmmeter TS-294/U, the voltage is applied to the grid of V1 (fig. 10). The action of the amplifier circuit is opposite to that explained in subparagraph **a.** The terminals of the meter are reversed by the SELECTOR switch, however, so that the meter still reads in the same direction. In this circuit R22 calibrates the meter for both positive and negative voltage readings.

20. D-C VOLTAGE MEASUREMENTS.

The d-c voltage to be measured is applied to the DC VOLTS jack (figs. 10 and 11). The voltage at the jack is applied to the voltage divider consisting of R1 through R6. The sum of the resistors in the voltage divider and the resistance in the d-c probe is 11 megohms, which constitutes the d-c input resistance of the meter. The various voltage ranges are obtained by setting the center tap of switch S1A at different points on the voltage divider.

21. RESISTANCE MEASUREMENTS.

a. When the SELECTOR switch is in the OHMS position, the grid of V2 is grounded and the grid of V1 is connected to the ohms section of the RANGE switch, S1B (figs. 10 and 11). A d-c voltage from the battery is applied to the grid of V1 causing the meter to read full scale, which corresponds to infinite resistance. The OHMS ADJ. control, R23, is adjusted to bring the meter reading exactly to full scale.

b. If an external resistance is connected between the OHMS-AC lead and the COMMON lead (between grid of V1 and ground), a current flows through the external resistor causing a voltage drop which is dependent on the resistance. The voltage drop at the grid of V1 causes a decrease in the meter reading which is calibrated to indicate the resistance of the unknown resistor. In order to adjust the circuit, the ohms probe is shorted to the common probe, grounding the grid of V1, and the ZERO ADJ. control, R21, is adjusted until the meter reads zero.

c. Different ranges of resistance are read by setting the center tap of switch S1B at different points on the voltage divider R7 to R12, thus placing varying amounts of resistance in series with the external resistance.

22. A-C VOLTAGE MEASUREMENTS.

a. When the SELECTOR switch is in the AC VOLTS position, the microammeter is disconnected from the d-c amplifier circuit and is connected through the rectifiers and the a-c volts section of the RANGE switch to the OHMS-AC and COMMON jacks (figs. 10 and 11). A simplified schematic diagram of the circuit is shown in figure 9.

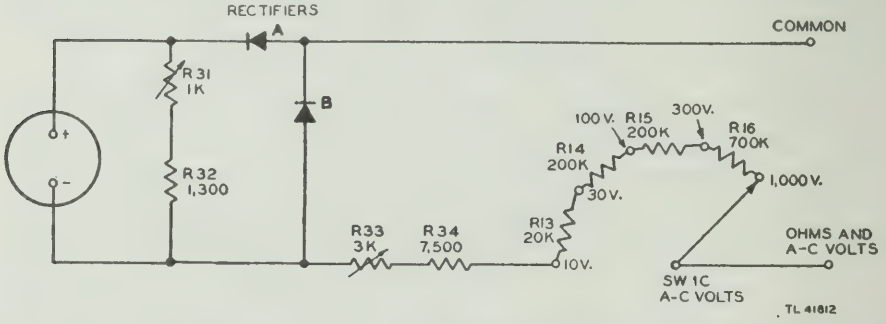


Figure 9. A-C circuit, simplified schematic diagram.

b. The rectifiers, A and B, are copper-oxide rectifier elements, which have a much lower resistance to current flow in one direction than in the opposite direction. On negative half-cycles, electrons flow from the input jack, through the meter and rectifier A, and back to the common jack. On positive half-cycles, electrons are blocked from flowing through rectifier A, and the circuit through the meter is effectively opened. Thus direct current

21. RESISTANCE MEASUREMENTS.

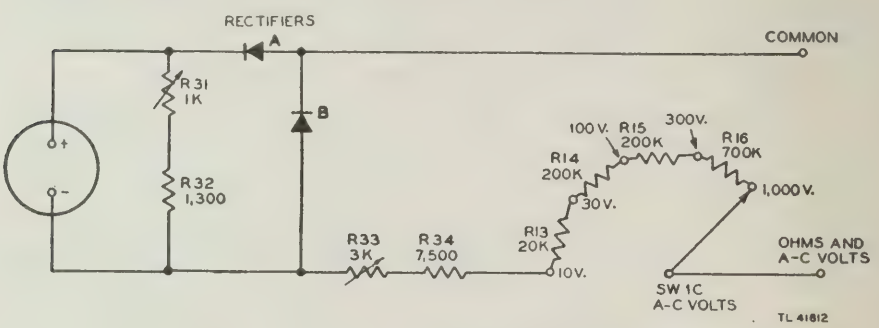
a. When the SELECTOR switch is in the OHMS position, the grid of V2 is grounded and the grid of V1 is connected to the ohms section of the RANGE switch, S1B (figs. 10 and 11). A d-c voltage from the battery is applied to the grid of V1 causing the meter to read full scale, which corresponds to infinite resistance. The OHMS ADJ. control, R23, is adjusted to bring the meter reading exactly to full scale.

b. If an external resistance is connected between the OHMS-AC lead and the COMMON lead (between grid of V1 and ground), a current flows through the external resistor causing a voltage drop which is dependent on the resistance. The voltage drop at the grid of V1 causes a decrease in the meter reading which is calibrated to indicate the resistance of the unknown resistor. In order to adjust the circuit, the ohms probe is shorted to the common probe, grounding the grid of V1, and the ZERO ADJ. control, R21, is adjusted until the meter reads zero.

c. Different ranges of resistance are read by setting the center tap of switch S1B at different points on the voltage divider R7 to R12, thus placing varying amounts of resistance in series with the external resistance.

22. A-C VOLTAGE MEASUREMENTS.

a. When the SELECTOR switch is in the AC VOLTS position, the microammeter is disconnected from the d-c amplifier circuit and is connected through the rectifiers and the a-c volts section of the RANGE switch to the OHMS-AC and COMMON jacks (figs. 10 and 11). A simplified schematic diagram of the circuit is shown in figure 9.



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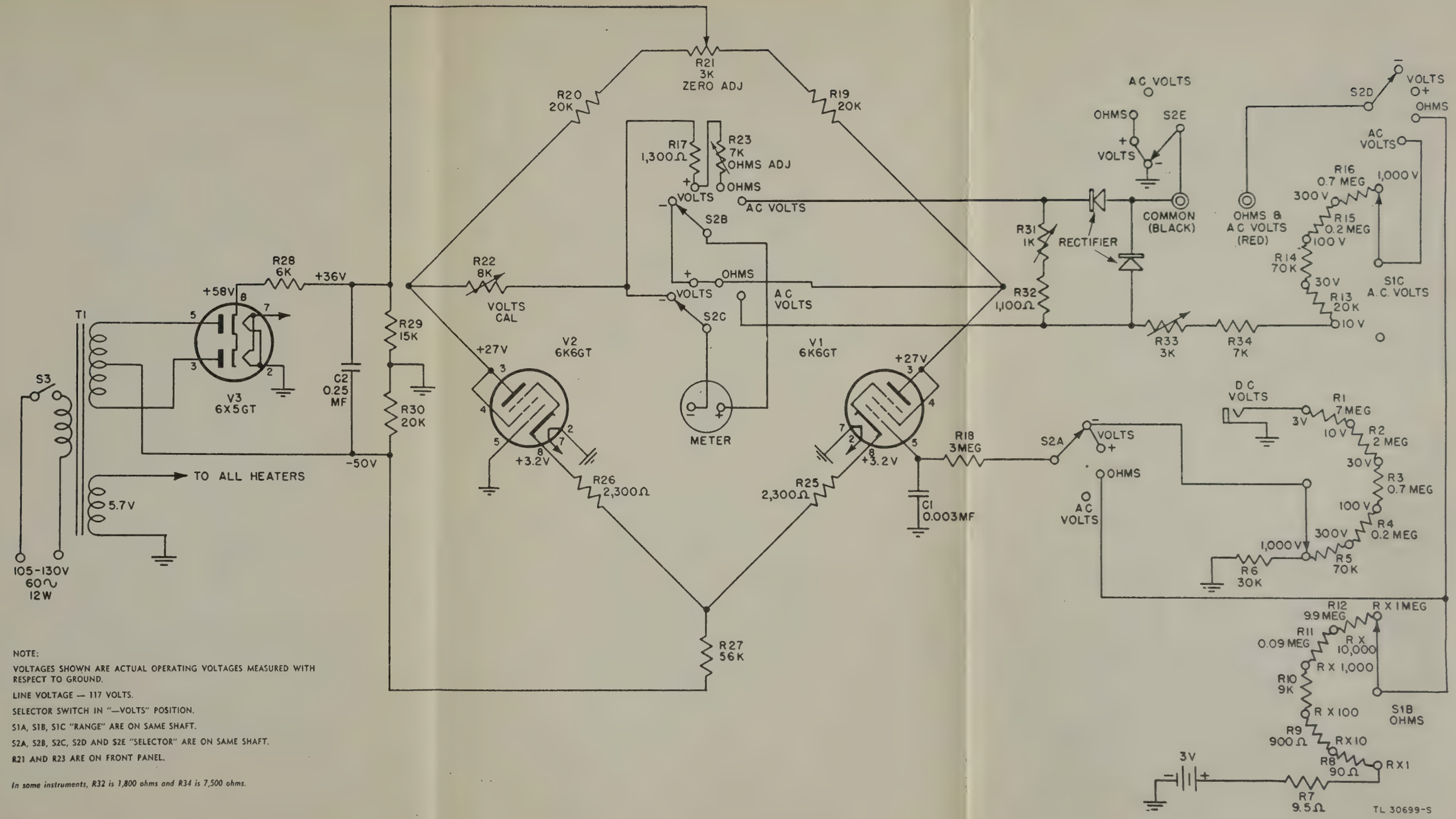

NOTE:

VOLTAGES SHOWN ARE ACTUAL OPERATING VOLTAGES MEASURED WITH RESPECT TO GROUND.

LINE VOLTAGE — 117 VOLTS.

SELECTOR SWITCH IN "—VOLTS" POSITION.

S1A, S1B, S1C "RANGE" ARE ON SAME SHAFT.

S2A, S2B, S2C, S2D AND S2E "SELECTOR" ARE ON SAME SHAFT.

R21 AND R23 ARE ON FRONT PANEL.

In some instruments, R32 is 1,800 ohms and R34 is 7,500 ohms.

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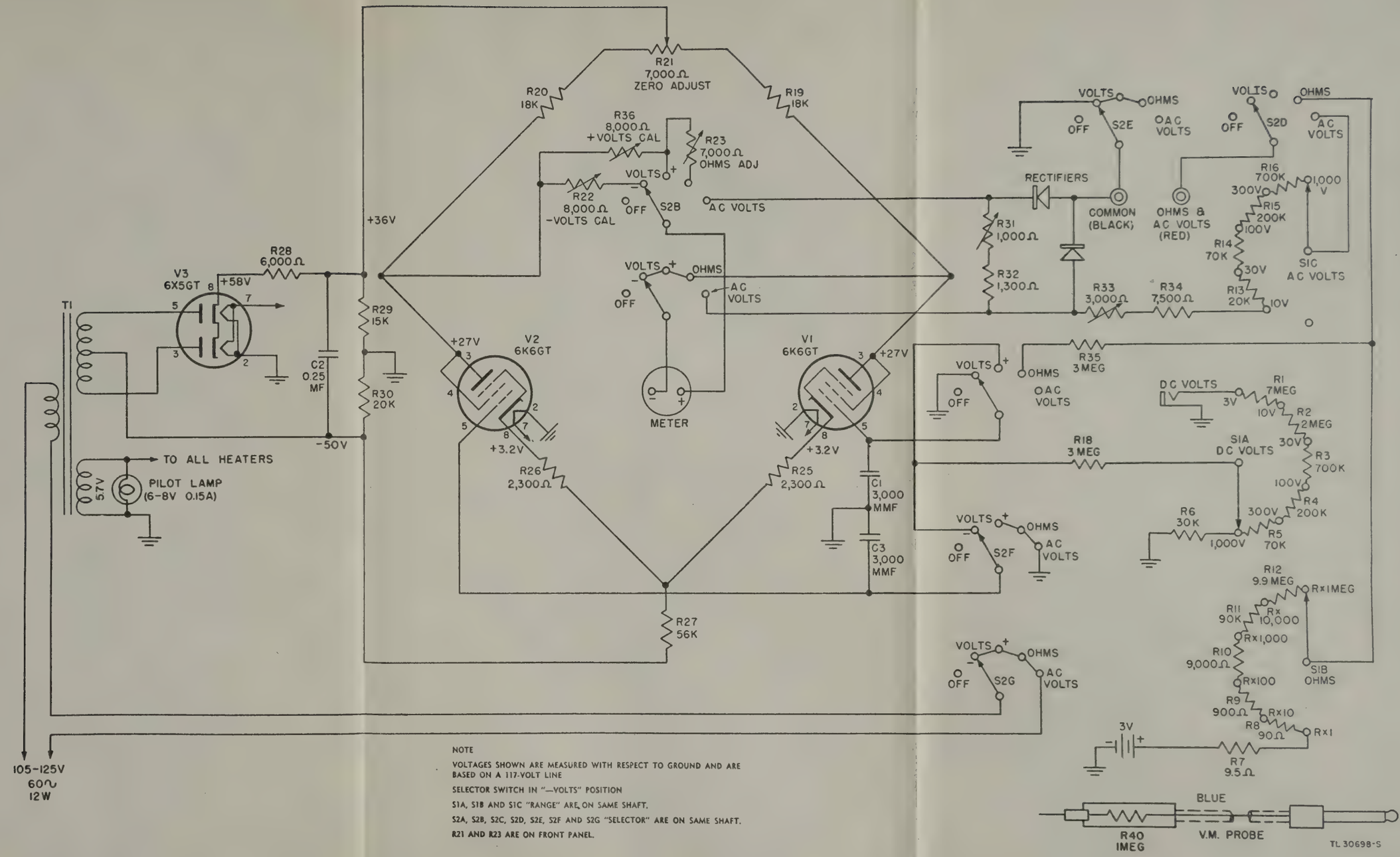
Figure 10. Voltohmmeter TS-294/U, complete schematic diagram.



NOTE

VOLTAGES SHOWN ARE MEASURED WITH RESPECT TO GROUND AND ARE BASED ON A 117-VOLT LINE

SELECTOR SWITCH IN "—VOLTS" POSITION

S1A, S1B AND S1C "RANGE" ARE ON SAME SHAFT.

S2A, S2B, S2C, S2D, S2E, S2F AND S2G "SELECTOR" ARE ON SAME SHAFT.

R21 AND R23 ARE ON FRONT PANEL.

Figure 11. Voltohmmeter TS-294B/U, complete schematic diagram.

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flows through the meter and is proportional to the a-c voltage applied at the input jack. Resistors R31 and R33 are adjusted to calibrate the a-c voltage readings.

c. Rectifier B is necessary to enable the meter to read when there is a blocking capacitor between the meter and the source of a-c voltage. (A capacitor may be a part of the circuit under test or may have been inserted between the voltmeter and the source of voltage to block a d-c component.) Without rectifier B a capacitor in the circuit quickly becomes charged on negative half-cycles (when rectifier A conducts) to the peak value of the a-c voltage. Thereafter no d-c current can flow in the circuit and the meter reads zero. When rectifier B is in the circuit, the capacitor discharges through rectifier B on positive half-cycles so that current can flow through the meter and rectifier A again on negative half-cycles. A direct current can thus be maintained through the meter circuit.

23. POWER SUPPLY.

a. The power supply consists of V3, a 6X5GT tube, connected as a full-wave rectifier (figs. 10 and 11). Plate and filament voltages are supplied from power transformer T1.

b. The output of the power supply is filtered by the resistance-capacitance (R-C) filter, R28 and C2. A high degree of regulation is not required since operation of the bridge circuit is essentially independent of the total voltage across the bridge.

c. The output is applied across the bleeder, R29 and R30. The junction of these two resistors is grounded so that both negative and positive voltages are obtained from the power supply. This is necessary because of the large resistance in the cathode circuit of the d-c amplifiers.

24. SERVICING.

Use care in maintaining and servicing this equipment. Servicing and repair other than the replacement of tubes should be performed only by competent personnel supplied with proper tools and instruments. An inexperienced operator attempting to locate and repair trouble may damage the equipment to such an extent that shipment to a higher repair echelon will be necessary. This precaution cannot be overemphasized.

25. GENERAL REPAIR.

The procedures involved in removing and replacing defective parts or circuit elements in this equipment are critical; great care must be taken to avoid further damage to the equipment or to the part being replaced. Before attempting repairs, obtain the proper tools for the job.

a. Identification of Leads. It may often be necessary to remove other circuit elements in order to gain access to the defective part. To insure proper reinstallation, make a record of the connections to each removed element and of the position of the element in the equipment.

b. Electrical Connections. When renewing leads, clip them as short as possible for satisfactory connection. Do not use more solder than necessary to make a secure connection. A slight amount of excess solder dropped accidentally inside the equipment may cause other circuits or circuit elements to become short-circuited. Some clearances inside the instrument are very small, and extreme care must be taken when soldering. Do not heat the lug or connection more than is absolutely necessary because of possible damage to near-by elements. When a wire is connected to a tube socket, the connecting wire should be long enough to prevent pull on the socket. Save time and trouble by making a thorough electrical check of any part that appears to be defective **before** removing it from the voltohmmeter.

26. GENERAL TROUBLE-SHOOTING NOTES.

a. Trouble-shooting Information. The information in this paragraph applies to all models of the instrument. The partial and complete schematic diagrams (figs. 8, 9, 10, and 11) will be helpful in trouble shooting. In addition, figures showing the location of all parts and the differences in location of parts on different models (figs. 12, 13, 14, 15, and 16) are included at the end of paragraph **29**.

b. Preliminary Check. When faulty operation of the instrument develops, the instrument should be checked against a moving-coil meter on the d-c ranges, or any good rectifier or moving-iron type meter on the a-c ranges. This check is made by placing the instrument in parallel with the standard calibrating meter and comparing the readings.

c. Localizing Trouble.

(1) The most direct method of localizing trouble is to observe the meter scale when measuring a-c and d-c voltages on the several ranges. Interpretations of the manner in which the voltmeter behaves under various conditions will quickly indicate the probable location of the fault.

(2) For the purpose of trouble shooting the instrument, determine whether the trouble is located in: meter, tubes, power supply, d-c amplifier, or leads. Normally, the parts of the instrument should be checked in the order in which they are listed above.

(3) If no indication can be obtained on any d-c range, the fault is probably in the power supply or in the d-c amplifier circuit.

(4) If the operation of the instrument is faulty on a particular range only, the fault is probably in the switch contact associated with that range.

(5) If the instrument works properly on d-c ranges and not on a-c ranges, it is unnecessary to check the power supply, the d-c amplifier, and the meter. The fault probably lies in the rectifiers, the leads, or the switching.

(6) When the operation of the instrument is faulty on both the a-c and d-c ranges, the fault is probably in the meter.

d. Initial Steps.

(1) If the pointer reads off scale in either direction on d-c ranges, turn the power off and localize the trouble by means of a resistance check of the circuit.

(2) If a resistance check does not locate the trouble quickly and if the tubes have been checked, the meter should be shorted by a piece of wire connected between its terminals, the power turned on, and a voltage check made. Usually this method is more convenient that making a cold resistance check.

e. Precautions.

(1) To check the 200-microampere meter, do not use an ordinary ohmmeter on the low-resistance range because the ohmmeter test current will burn out the meter. Test the meter for continuity on the medium or high resistance range.

(2) If the d-c amplifier tubes V1 and V2 are removed for testing or temporarily replaced by other tubes in an attempt to clear the fault, note the socket from which each tube is removed in order that it can be replaced in the same socket if it is not defective.

f. Matching of Amplifier Tubes.

(1) If it is necessary to replace either tube V1 or V2, more satisfactory operation will be obtained by selecting tubes which have approximately the same characteristics. If the tubes are "matched," it will be possible to adjust the zero on the d-c ranges by means of the ZERO ADJ. control with this control in approximately the middle of its range.

(2) If the amplifier tubes are unbalanced, it may be impossible to bring the pointer to zero by means of the ZERO ADJ. control. If this happens, the tubes should be interchanged and the adjustment tried again. If it is still impossible to bring the pointer to zero, the tubes have different characteristics and each one should be matched with another tube in order to obtain a balanced pair. When the tubes are matched, it will be possible to bring the pointer to zero with the ZERO ADJ. control, provided there is no other trouble in the circuit.

(3) Grid current is normally negligible in the amplifier circuit. However, when replacing tubes, it is advisable to check for grid current because

an occasional gassy tube will be found. The presence of gas is indicated by an appreciable change in the pointer position when the RANGE switch is changed from the 3V. to the 30 V. position while the SELECTOR switch is in the +VOLTS position.

27. CHECKING POWER SUPPLY.

a. A fault in the power supply causes faulty operation on both d-c voltage and resistance measurements. To check the power supply, measure the positive and negative voltage output at the ungrounded ends of R29 and R30. The voltages should be +36 and —50 volts respectively.

b. All the filaments in the circuit are supplied from one winding on the transformer. Note that the filament voltage used is lower and usual for 6-volt tubes, namely 5.7 volts. If faulty operation of the power supply is indicated and the pilot light does not glow, the filament winding and primary on the power transformer T1 should be checked.

28. CHECKING D-C AMPLIFIER.

a. A fault in the d-c amplifier affects the operation of both the d-c voltage and resistance ranges. To check the d-c amplifier, turn the SELECTOR switch to the +VOLTS or —VOLTS position, short the DC and COMMON leads, and turn on the power. The RANGE switch may be in any position. Short the meter terminals if the meter pointer deflects off scale.

b. Measure the voltage at the plate and the cathode of V1 and V2. The voltage at each plate should be approximately 26 volts; the voltage at each cathode should be approximately 3.2 volts. If the cathode voltage reading of either tube is negative, the tube is not drawing any plate current.

c. If the voltages are incorrect, turn off the power and check the cathode resistors R25 and R26. Check the continuity of the circuit against the schematic diagram (figs. 10 and 11). Do not check the meter for continuity with an ordinary ohmmeter, since the meter will be overloaded and may be burned out.

29. CHECKING A-C CIRCUIT.

If the readings are normal on d-c and resistance ranges but not on a-c ranges, replace the rectifiers. If the fault is not cleared, check the switch contacts involved and the continuity of the circuit.

30. CALIBRATION.

a. D-C Calibration Adjustment. Voltohmmeter TS-294B/U is provided with two d-c calibration adjustments, potentiometers R22 and R36 (figs. 14 and 15), which are set originally at the factory to compensate for variations in meter sensitivity and tube characteristics. Voltohmmeter TS-294/U has

only one of these adjustments, R22 (fig. 16). These adjustments ordinarily do not require changing except when tubes are replaced. The adjustment procedure given below applies to Voltohmmeter TS-294B/U. If the TS-294/U model is being adjusted, omit steps *(8)* and *(9)*.

(1) Remove the power cord from the a-c supply.

(2) Remove the six screws from the front panel and the two screws from the back of the case.

(3) Carefully pull the meter chassis from the case, lay the case on its back, and place the rear edge of the meter chassis on the edge of the case so that the case supports the meter.

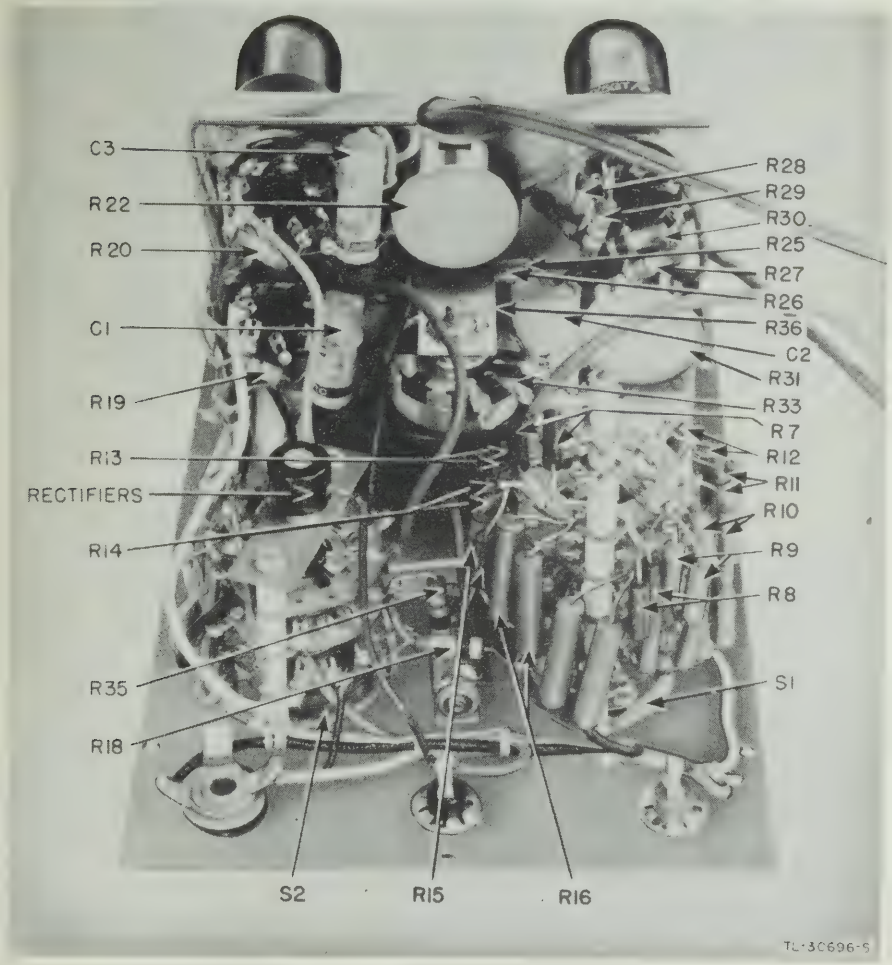


Figure 12. Voltohmmeter TS-294B/U, bottom of chassis.

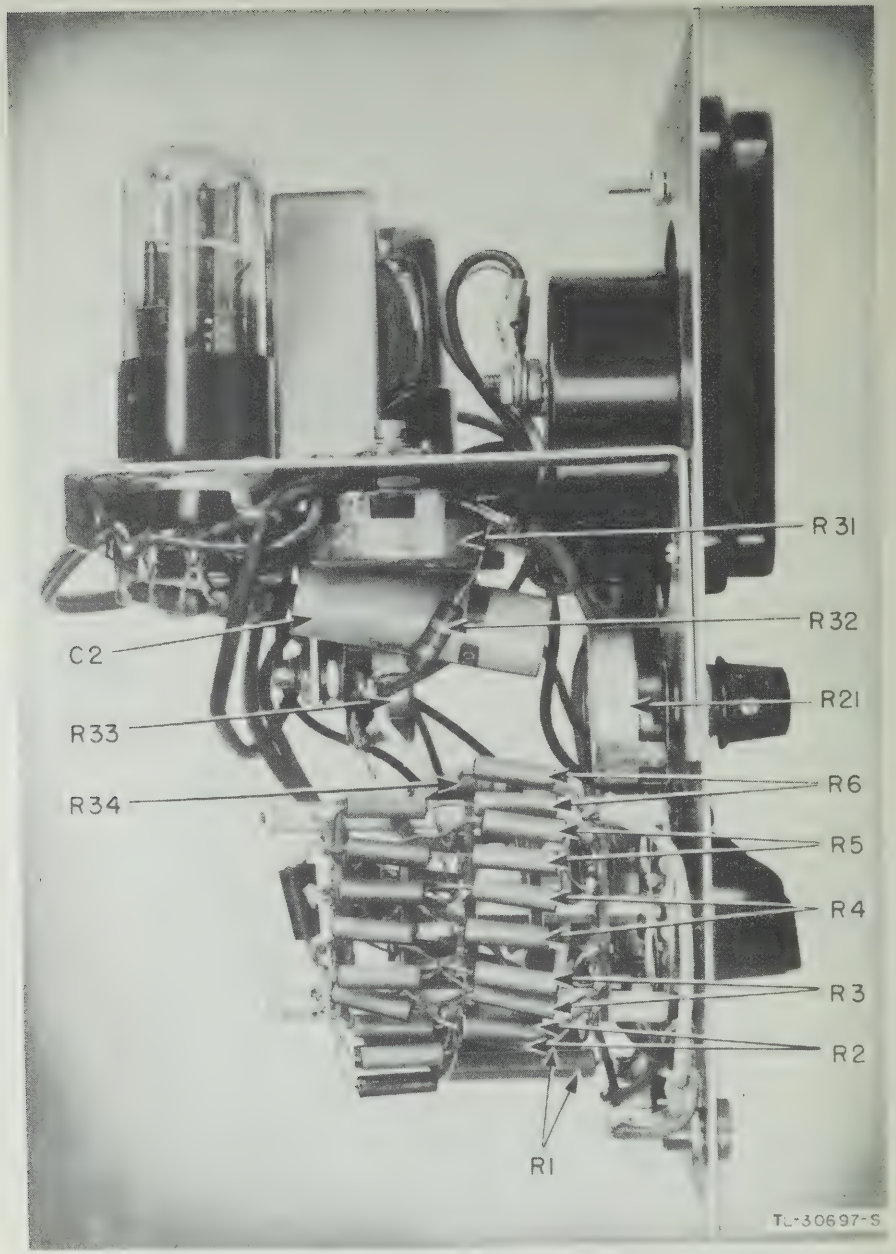


Figure 13. Voltohmmeter TS-294B/U, side of chassis.

(4) Plug the power cord into the a-c power source, turn the SELECTOR switch to the +VOLTS position and the RANGE switch to the 3V.DC position. Allow the instrument to warm up for 30 minutes.

(5) Adjust the ZERO ADJ. control until the meter reads exactly zero.

(6) Plug the black cord into the COMMON jack and the probe cord into the DC VOLTS jack.

(7) Connect the voltmeter, using the above cords, across a standard source of exactly 3 volts. The precision of the instrument calibration depends upon the accuracy of the 3-volt source. This source should be checked carefully with a voltmeter known to be accurate. The 3 volt source may be the voltage drop across an accurate 1,000-ohm resistor which has exactly 3 milliamperes of current flowing through it.

(8) Adjust R36 (figs. 14 and 15) so that the meter reads exactly 3 volts on the V.D.C. scale.

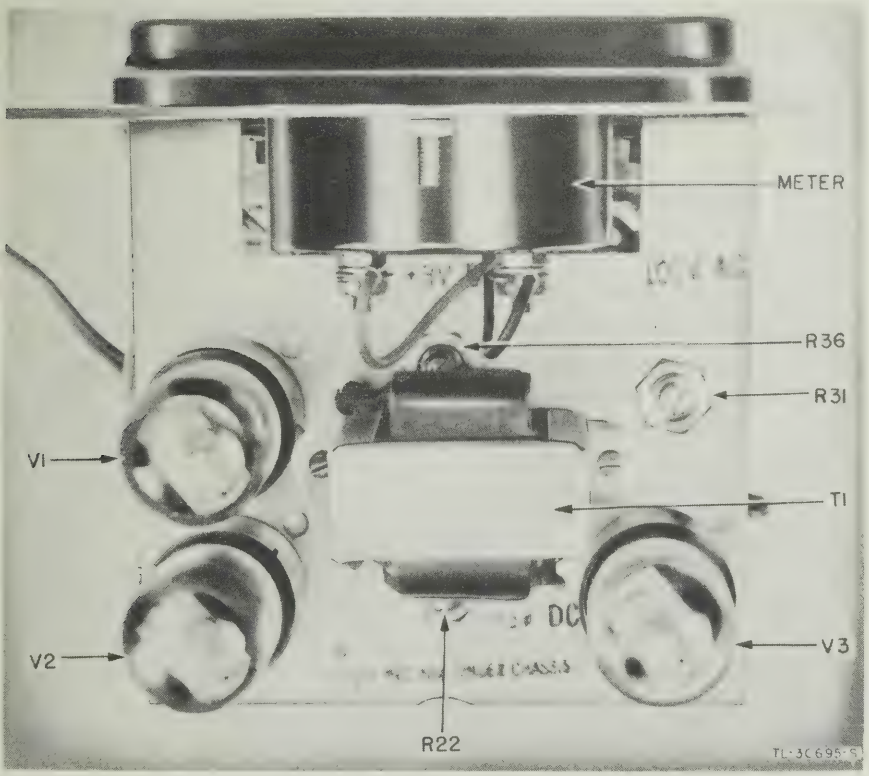


Figure 14. Voltohmmeter TS-294B/U, top of chassis.

(9) Remove the test leads from the 3-volt source, turn the SELECTOR switch to the —VOLTS position, reverse the leads to obtain proper polarity, and reconnect the leads across the source.

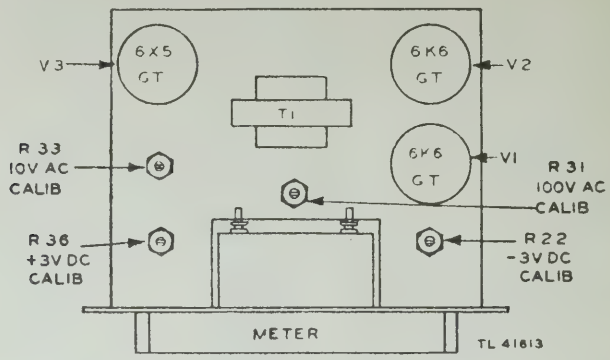


Figure 15. Voltohmmeter TS-294B/U, top of chassis, alternate arrangement.

(10) Adjust R22 (figs. 14 and 15) so that the meter reads exactly 3 volts.

(11) After the adjustment is completed, the two 6K6GT tubes should not be interchanged, since this may have a slight effect on the accuracy of the calibration.

(12) To install the chassis in the case, reverse the procedure given above.

b. A-C Calibration Adjustment. Two internal adjustments, potentiometers R31 and R33 (figs. 13 and 15), which are preset at the factory, are provided to compensate for variations in both rectifier and meter characteristics and to insure the greatest possible accuracy of the d-c ranges. These adjustments should not be changed unless one or more of the components in the a-c voltmeter section of the circuit is replaced. The procedure is the same for

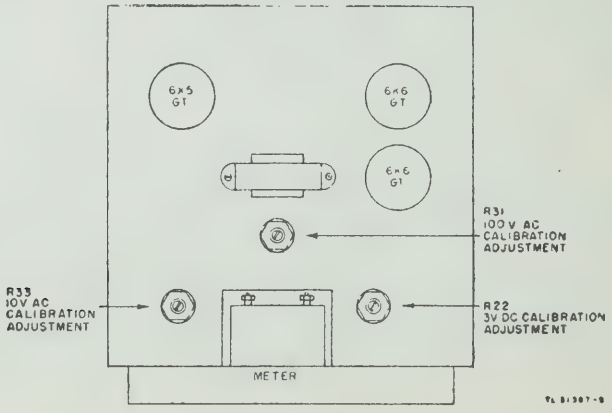


Figure 16. Voltohmmeter TS-294/U, top of chassis.

Voltohmmeters TS-294/U and TS-294B/U. If it is necessary to recalibrate the instrument, proceed as follows:

(1) Remove the power cord from the a-c supply.

(2) Remove the chassis from the case.

(3) Set the SELECTOR switch in the AC VOLTS position and the RANGE switch in the 100V. position.

(4) Plug the power cord into the a-c supply.

WAR DEPARTMENT
UNSATISFACTORY EQUIPMENT REPORT

FOR	TECHNICAL SERVICE: Signal Corps — MATÉRIEL		DATE: 20 Feb. 1945
FROM	ORGANIZATION: 885 Signal Repair Co.		STATION: APO 258 New York
TO	NEXT SUPERIOR HEADQUARTERS: Signal Officer	STATION: Army	TECHNICAL SERVICE

COMPLETE MAJOR ITEM

NOMENCLATURE: Voltohmmeter TS-294-U	TYPE	MODEL: RCA 165 A	
MANUFACTURER: Radio Corp. of America	U. S. A. REG. No.: Order No. 1872-MPD-44	SERIAL No.: 6220	DATE RECEIVED: 15 Dec. 1944
EQUIPMENT WITH WHICH USED (*If applicable*): Test Set AN/GPM-1			

DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE

PART No.	TYPE	MANUFACTURER	DATE INSTALLED
R28	Resistor	National Corp.	20 Dec. 1944

DESCRIPTION OF FAILURE AND PROBABLE CAUSE (*If additional space is required, use back of form*): Burned out

DATE OF INITIAL TROUBLE	TOTAL TIME INSTALLED			TOTAL PERIOD OF OPERATION BEFORE FAILURE					
	YEARS	MONTHS	DAYS	YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
26 Jan. 1945		1	6				30		

BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN: No unusual conditions

TRAINING OR SKILL OF USING PERSONNEL			RECOMMENDATIONS (*If additional space is required, use back of form*)
POOR	FAIR	GOOD	Replacement should be available

ORIGINATING OFFICER

TYPED NAME, GRADE, AND ORGANIZATION	SIGNATURE
HAROLD T. MASON, CAPT. SIG. C. 885 SIG. REPAIR CO.	Harold T. Mason

FIRST ENDORSEMENT

TO CHIEF	TECHNICAL SERVICE	OFFICE	
NAME, GRADE, AND STATION		STATION	DATE

Instructions

1. It is imperative that the chief of technical service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.
2. This form will be used for reporting manufacturing, design, or operational defects in matériel, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of matériel.
3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records.
4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (change No. 3).
5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable.
6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.
7. This form will be made out in triplicate by using or service organization. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels.
8. Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468
20 August 1944

This form supersedes W. D., A. G. O. Form No. 468, 1 December 1943, which may be used until existing stocks are exhausted.

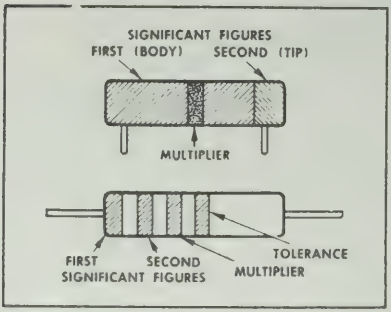
TL 31388-S

U. S. GOVERNMENT PRINTING OFFICE 19—41548-1

Figure 17. Sample Unsatisfactory Equipment Report.

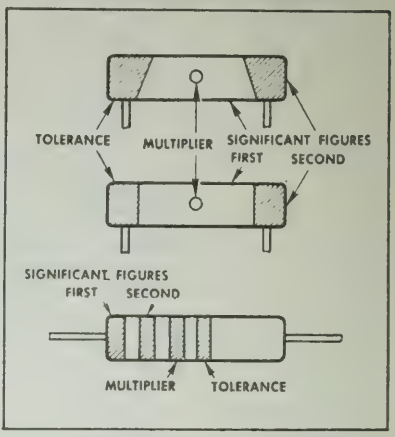
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

AWS COLOR CODE FOR FIXED COMPOSITION RESISTORS



The exterior body color of insulated resistors may be any color except black. The usual color is natural tan. The exterior body color of uninsulated resistors with axial leads may be either black or white. The exterior body color of uninsulated resistors with radial leads may be black or it may be the color of the first significant figure of the resistance value.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000	
GRAY	8	100,000,000	
WHITE	9	1,000,000,000	
GOLD		0.1	5
SILVER		0.01	10
NO COLOR			20

RMA: *Radio Manufacturers Association*
AWS: *American War Standard (American Standards Association)*

TL 13418

Figure 18. Resistor color code chart.

(5) Plug the black cord into the COMMON jack and the red cord into the OHMS-AC jack.

(6) Apply a standard a-c voltage of exactly 100 volts to the test leads. This voltage should have good waveform and should be measured by an instrument of known accuracy.

(7) Adjust R31 (figs. 14 and 15) so that the meter reads exactly 100 volts (full scale) on the V.A.C. scale.

(8) Remove the 100 volts and apply a voltage of 10 volts to the test leads. Set the RANGE switch to the 10V. position.

(9) Adjust R33 (figs. 13 and 15) so that the meter reads exactly 10 volts (full scale) on the V.A.C. scale.

(10) The procedure for adjusting R31 and R33 should be repeated until no further change is required. Usually it will not be necessary to go over the adjustment more than twice.

(11) Replace the chassis in the case.

31. UNSATISFACTORY EQUIPMENT REPORT.

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, War Department Unsatisfactory Equipment Report, W.D., A.G.O. Form No. 468 (fig. 17) should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C.

b. When trouble in equipment used in Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form No. 54 should be filled out and forwarded through channels.

c. If either form is not available, prepare the data according to the sample form reproduced in figure 17.

32. MAINTENANCE PARTS FOR VOLTOHMMETERS TS-294/U AND TS-294B/U.

The following information was compiled on 21 March 1945. The appropriate sections of the ASF Signal Supply Catalog for Voltohmmeters TS-294/U and TS-294B/U are:

Organizational Spare Parts

SIG 7 - IE-9 (when published)

Higher Echelon Spare Parts

SIG 8 - TS-294/U

For the index of available catalog sections, see the latest section of ASF Signal Supply Catalog SIG 2.

32. MAINTENANCE PARTS FOR VOLTOHMMETERS TS-294/U AND TS-294B/U *(contd)*.

Model Nos.[1]	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*
		3F14050	VOLTOHMMETER: Sig C Voltohmmeter TS-294/U; vacuum tube voltmeter; portable; DC and AC; voltmeter ranges from 0 to 3/10/30/100/300/1,000, ohmmeter ranges from 0.1 ohm to 1,000 meg; welded steel case, 9⅜" h x 5⅞" wd x 5⁹⁄₁₆" d over-all.
	B1	3A-205	BATTERY, dry: Sig C Battery BA-205/U; 3v; rectangular; 1⁵⁄₁₆" d x 2⅝" wd x 4⁷⁄₁₆" h over-all; Burgess #F2BP or equal.
		3E4400-4	CABLE ASSEMBLY, power: rubber-covered; 72" lg; 2 cond #18 AWG; RCA #14086 (rubber spring action male connector at 1 end, other end skinned and tinned).
	C1, C3	3K3030232	CAPACITOR, fixed: mica; 3,000 mmf ±5%; 500 vdcw; max dimen ⁵³⁄₆₄" x ⁵³⁄₆₄" x ⁹⁄₃₂"; CM30C302J.
	C2	3DA250-82	CAPACITOR, fixed: paper; 250,000 mmf ±10%; 200 vdcw; 1¾" lg x ⅝" diam; Aerovox type #284; RCA #12484.
		2Z5573.8	CONNECTOR, female contact (jack): 1 cont; banana type; black insulation; for ⅛" plug; RCA #43920.
		2Z5573.7	CONNECTOR, female contact (jack): 1 cont; banana type; red insulation; for ⅛" plug; RCA #43919.
		2Z5534	JACK, telephone: Sig C Jack JK-34; for 2 cond 0.25" diam plug, 1¼" lg x ¾" diam over-all; RCA #43921 (marked DC VOLTS).
		2Z5842-12	KNOB, round: black bakelite; for ¼" diam shaft; ¾" diam x ⅝" h over-all; RCA #4323.
		2Z5821-7	KNOB, bar: black bakelite; for ¼" diam shaft; 1³⁄₁₆" lg x ¾" diam x ⅝" h over-all; Davies Molding Co #2300.
165		2Z5925	LAMP, incandescent: Sig C Lamp LM-25; 6.3v, 0.25 amp; bulb T-3-¼ clear; miniature screw base; Mazda type #40.

165A		2Z5952	LAMP, incandescent: Sig C Lamp LM-52; 6-8v, 0.15 amp; bulb T-3-¼ clear; miniature bayonet base; Mazda #47.
165A		2Z5883-117	LAMPHOLDER, assembly: miniature bayonet base; includes jewel and socket; steel body; 1½" h x ½" wd x 15/16" d over-all; RCA #47145.
165		2Z5882-53	LAMPHOLDER, assembly: miniature screw base; includes jewel and socket; steel body; over-all dimen 2⅝" h x ½" wd x ¾" d; RCA #44289; Dial Light #555F.
		3E4400-7	LEAD, test: RC; red; 50" lg; 1 cond #18 AWG, 16 strands #30; RCA #43913 (ICA phone tip plug #876R on 1 end, ICA alligator clip #364 on other end).
		3E4400-8	LEAD, test: RC; black; 50" lg; 1 cond #18 AWG, 16 strands #30; RCA #43914 (ICA phone tip plug #876B on 1 end, ICA alligator clip #364 on other end).
		3E4400-9	LEAD, test: RC; red; braid shield w/blue cotton braid outer covering; 50" lg; 1 cond #19 AWG stranded, 13 strands #30; RCA #43915 (Mallory #75 plug on 1 end, ICA #390B test prod at other end).
		3F872-4	METER, microammeter: 200 μa DC; scale range 0 to 3/10/30/100/300/1,000 AC and DC volts; ohmmeter 0.1 ohm to 1,000 meg; sq bakelite flush mtg case; 4⅝" wd x 4⅛" h x 1½" over-all depth; 2¾" body diam; RCA #43923.
		3F3778	RECTIFIER, metallic: copper oxide; 105-125v AC, 50/60 cyc; round, ½" h x 1" wd x ½" diam; RCA #43924 (half-wave, 3 connection).
	R7	3Z6960-21.7	RESISTOR, fixed: WW; 9.5 ohms ±1%; 1w; consists of 2 resistors matched in series, max max dimen ea 0.469" lg x 0.249" diam; IRC type BW-½.
	R8	3Z6960-21	RESISTOR, fixed: WW; 90 ohms ±1%; 1w; consists of 2 resistors matched in series, max max dimen ea 0.469" lg x 0.249" diam; IRC type BW-½.
	R9	3Z6960-19.2	RESISTOR, fixed: composition; 900 ohms ±1%; 1w; consists of 2 resistors matched in series, max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.

[1] Unless otherwise specified, parts are used in either model No. 165 (Voltohmmeter TS-294/U) or 165A (Voltohmmeter TS-294B/U).

32. MAINTENANCE PARTS FOR VOLTOHMMETERS TS-294/U AND TS-294B/U *(contd)*.

Model Nos.[1]	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*
165 165A	R17 R32	3RC20BE132J	RESISTOR, fixed: composition; 1,300 ohms ±5%; ½w; max dimen 0.468″ lg x 0.249″ diam; RC20BE132J.
	R25, R26	3RC31BE242J	RESISTOR, fixed: composition; 2,300 ohms ±5%; 1w; 1.28″ lg x 0.310″ diam; IRC type BT-1.
	R28	3RC20BF622J	RESISTOR, fixed: composition; 6,200 ohms ±5%; ½w; max dimen 0.469″ lg x 0.249″ diam; RC20BF622J.
	R34	3RC20BF752J	RESISTOR, fixed: composition; 7,500 ohms ±5%; ½w; max dimen 0.468″ lg x 0.249″ diam; RC20BF752J.
	R10	3Z6960-20	RESISTOR, fixed: composition; 9,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469″ lg x 0.249″ diam; IRC type BT-½.
	R29	3RC20BF153K	RESISTOR, fixed: composition; 15,000 ohms ±10%; ½w; max dimen 0.468″ lg x 0.249″ diam: RC20BF153K.
165	R32	3RC21BF183J	RESISTOR, fixed: composition; 18,000 ohms ±5%; ½w; max dimen 0.655″ lg x 0.249″ diam; RC21BF183J.
165A	R19, R20	3RC30BF183J	RESISTOR, fixed: composition; 18,000 ohms ±5%; 1w; max dimen 0.718″ lg x 0.280″ diam; RC30BF183J.
165 165A	R13, R20, R19 R13	3Z6960-19.21	RESISTOR, fixed: composition; 20,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469″ lg x 0.249″ diam; IRC type BT-½.
	R30	3RC20BF203J	RESISTOR, fixed: composition; 20,000 ohms ±5%; ½w; max dimen 0.469″ lg x 0.249″ diam; RC20BF203J.
	R6	3Z6960-21.13	RESISTOR, fixed: composition; 30,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469″ lg x 0.249″ diam; IRC type BT-½.

	R27	3RC20BE563K	RESISTOR, fixed: composition; 56,000 ohms ±10%; ½w; 0.469" lg x 0.249" diam; RC20BF563K.
	R5, R14	3Z6960-21.02	RESISTOR, fixed: composition; 70,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.
	R11	3Z6960-21.4	RESISTOR, fixed: composition; 90,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.
	R4, R15	3Z6960-21.8	RESISTOR, fixed: composition; 200,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.
	R3	3Z6960-21.6	RESISTOR, fixed: composition; 700,000 ohms ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.
	R16	3Z6960-21.10	RESISTOR, fixed: composition; 700,000 ohms ±1%; 1w; consists of 2 resistors matched in series; max dimen ea 1.28" lg x 0.310" diam; IRC type BT-1.
	R2	3Z6960-21.5	RESISTOR, fixed: composition; 2 meg ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.
165 165A	R18 R18, R35	3RC20BF305J	RESISTOR, fixed: composition; 3 meg ±5%; ½w; max dimen 0.468" lg x 0.249" diam; RC20BF305J.
	R1	3Z6960-21.11	RESISTOR, fixed: composition; 7 meg ±1%; 1w; consists of 2 resistors matched in series; max dimen ea 1.28" lg x 0.310" diam; IRC type BT-1.
	R12	3Z6960-21.3	RESISTOR, fixed: composition; 9.9 meg ±1%; ½w; consists of 2 resistors matched in series; max dimen ea 0.469" lg x 0.249" diam; IRC type BT-½.
	R31	3Z7310-27	RESISTOR, variable: WW; 1,000 ohms ±10%; 2w; 1¼" diam x 9/16" thk; RCA #43918 (shunt adjustment).
165 165A	R21, R33 R33	2Z7269.26	RESISTOR, variable: WW; 3,000 ohms ±10%; 2w; 1¼" diam x 9/16" thk; IRC type #VW591; RCA #43922 (zero and AC series adjustment).

[1] Unless otherwise specified, parts are used in either model No. 165 (Voltohmmeter TS-294/U) or 165A (Voltohmmeter TS-294B/U).

32. MAINTENANCE PARTS FOR VOLTOHMMETERS TS-294/U AND TS-294B/U *(contd).*

Model Nos.[1]	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*
165A 165	R23, R21 R23	3Z7370	RESISTOR, variable: WW; 7,000 ohms ±10%; 2w; 1¼" diam x 9/16" d behind panel; IRC type #VW687; RCA #43917 (zero and ohms adjustment).
165A 165	R22, R36 R22	2Z7280-59	RESISTOR, variable (potentiometer): WW; 8,000 ohms; 2w; over-all dimen 1¼" body diam x 9/16" d behind panel bushing; RCA #43916 (D-C calibration adjustment).
		2ZK8678.21	SOCKET, tube: octal; bakelite laminated wafer term; cadmium-pl; 1 13/16" lg x 1 13/32" diam; RCA dwg #31251.
		6Z4996-7	STRAP ASSEMBLY, carrying: black leather; complete w/fasteners; over-all dimen 10¾" lg x 1" wd x ⅛" thk; RCA #44091 (removable).
165A	S2	3Z9825-62.78	SWITCH, rotary: 5 pole, 5 position; 3 sect; bakelite insulation; over-all dimen 1⅞" diam x 2¼" d behind panel; Oak type #19840-H2; RCA part #43939, (selector).
165	S2	3Z9825-62.79	SWITCH, rotary: 5 pole, 4 position; 2 sect; bakelite insulation; over-all dimen 1⅞" diam x 2¼" d behind panel; Oak #19840-H2; RCA part #43939 (selector).
	S1	3Z9825-62.77	SWITCH, rotary: 3 pole, 6 position; 5 sect; bakelite insulation; over-all dimen 1⅞" diam x 3¼" d behind panel; Oak type #25525-H5; RCA part #43938 (2 dummy sect used for term boards) (range switch).
165	S3	2Z9858-8.159	SWITCH, toggle: SPST; steel; approx over-all dimen 1⅜" lg x ⅝" wd x 1½" h; RCA #14551 (on-off).
	T1	2Z9613.64	TRANSFORMER, power: plate and fil; pri 105-125v; 50/60 cyc; 2 secd; unshielded; 2¾" h x 2¾" wd x 1½" d over-all; RCA #43940.
		2J6K6GT	TUBE, electron: JAN-6K6GT.
		2J6X5GT	TUBE, electron: JAN-6X5GT.

[1] Unless otherwise specified, parts are used in either model No. 165 (Voltohmmeter TS-294/U) or 165A (Voltohmmeter TS-294B/U).

U. S. GOVERNMENT PRINTING OFFICE : O—1949